Pre-hospital care among victims of road traffic injuries in Iran - A cross-sectional study on time intervals

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Abstract

Background

Road traffic injuries (RTIs) are a major public health problem, requiring concerted efforts for prevention and reducing its consequences. On-time arrival of the Emergency Medical Service (EMS) at crash scene and victims transportation by trained personnel may reduce the RTIs consequences. The first 60 minutes after injury occurrence - called “golden hour”- is most effective in saving lives. The present study was designed to estimate the average of various time intervals of pre-hospital care and to examine association and difference of these time intervals between city and interurban roads.

Method

A retrospective cross-sectional study was designed and various time intervals in relation to pre-hospital care of RTIs identified in the ambulance dispatch centre in Oroumiyeh, Iran from 20 March 2005 to 20 March 2007. All cases which resulted to ambulance dispatches were reviewed and those that had complete time intervals were analyzed in this study.

Results

After data set clean up, 2027 cases of RTIs victims were included and analysed in this study. Of these, 61.5 % of subjects were injured in city areas. The mean response time for city locations was 5.0 minutes compared with to 10.6 minutes for interurban roads locations. The mean scene time in the interurban roads was slightly longer than city (9.2 vs. 6.1 minutes, $p < 0.001$). Mean transport times from the scene to the hospital were also significantly longer for interurban incidents (17.1 minutes vs. 6.3 minutes). The mean of total pre-hospital time was 37.2(±17.2) minutes with a median of 32.0. In overall, 72.5% of the response interval time was less than eight minutes.

Conclusion

The response, transport and total time intervals among EMS responding to RTIs incidents were longer at interurban roads, compared to the city areas. More investigation should take place on needs-to and access-for EMS at city and interurban roads. Notification interval seems to be a hidden part of the post-crash events and indirectly affects on golden time of victims' management and it needs to be measured through establishment of the surveillance systems.

Background

Road traffic injuries (RTIs) are a major public health problem, requiring concerted efforts for prevention [1, 2]. The best strategy for RTIs control is crash prevention, which seems that it is impossible and crash can be occurred at any time [2-4]. However, it is often possible to minimize crash consequences by promptly providing effective pre-hospital services [4, 5]. Each year, many of the 1.2 million lives lost could be saved and much of the ensuing disability suffered by the 50 million injured could be prevented if rapid and competent pre-hospital services were available at the crash scene [1, 6].

In most low-and middle-income countries (LMICs), transport of the road traffic victims, is usually provided by relatives, taxi drivers, truck drivers, police officers and other motorists; which usually are untrained [7, 8]. Ground ambulances, if available, usually are only at urban areas [6]. Significant numbers of neurological injuries appear to be a function of victims extrication process or their transportation, without adequate immobilization [3, 9, 10], generally by untrained people [11]. Studies have shown that inadequacy of public health infrastructure and poor access to health services are important reasons for the high burden of RTIs and/or its severity [3]. Many LMICs have insufficient pre-hospital emergency medical services including on-time services and effective management of RTIs' victims and their transportation [12] and therefore its improvement and the system evaluation is crucial.

Pre-hospital care is unsatisfactory in many countries, especially in LMICs [7-9], which the majority of trauma deaths occur in the pre-hospital phase. On-time arrival of the EMS at crash scene and proper victims' transportation by trained personnel may reduce injury severity and reduce the number of preventable deaths. It is important to note that many trauma experts consider that the first 60 minutes after

injury occurrence - called “golden hour”- is most effective in saving lives [13]. After this time, the risk of death or injury severity rises significantly [13]. The golden time consisted of various time intervals, e.g. notification interval, activation interval, response interval, on-scene interval, and transport interval (see appendix 1).
Rapid responses are believed to be one of the most important criteria for the quality of care provided to trauma patients [13]. Measuring of these various time intervals can be an important step to evaluate the EMS function. However, to our knowledge there is a lack of information about the various pre-hospital time intervals of road traffic injuries and their differences at city and interurban roads area in Iran. The present study therefore was designed to estimate average of various time intervals of RTI at the pre-hospital phase by EMS to trauma centres in the capital city of West Azarbaijan Province (WAP) of Iran.

Method

This is a retrospective cross-sectional study on time intervals of RTIs that identified in the centre of ambulance dispatches sites from 20 March 2005 to 20 March 2007 in the Oroumiyeh city of Iran. The pre-hospital data of all RTIs were reviewed and average of different interval times was analyzed.

The emergency medical services in Iran

The aim of most EMS in overall is providing treatment to those in need of an urgent medical care, with the goal of satisfactorily treating the disease or injuries, or arranging for timely removal of the patients to the next point of definitive care. EMS in Iran provides services, mainly with ground ambulance, and helicopter ambulance in some cities. As described by Modaghegh et al., there are operators in the control facility of the EMS dispatch centres those answers the calls and usually are trained nurses. For each incoming call, the operator would determine whether the situation is

emergency and needs the dispatch of the EMS unit [14]. This process usually makes by a wireless telecommunication system for easier and more effective communication. After call to EMS and visiting the patients or victims, they mainly transferred to the nearest hospitals, which have been equipped to manage the most prominent problem of the victims [14]. Focusing on RTIs in Iran, EMS, the police and the fire brigades can all function as emergency services and take care of victim management when road traffic crashes occur. People can contact them by dialling the three-digit numbers of 115, 110 and 125, respectively [15].

Study area and study population

This study was undertaken in the capital city of the West Azarbaijan Province (WAP) of Iran, which is located in the province centre, in a mountainous area. WAP is shared with a common border with Iraq, Turkey and Russia Azerbaijan [16]. Due to feasibility of the study conducting in the capital city of the WAP, this city was chosen. Oroumiyeh population was about 887,318 in 2006. Thirty-two percent of the region's population reside in rural areas [17].

Data collection instrument

A standard questionnaire designed by the Ministry of Health and Medical Education in Iran, was used in this study. The questionnaire has demographic information of patients or victims including name, sex and age of patients, disease or external cause of injury and information about time of services including time of emergency receipt call, time of ambulance movement toward scene, time of arrival at scene, time of patients' transportation, time of arriving to hospital, time of leaving the hospital and time of arriving to ambulance depot, location of injury, (within cities or at interurban roads), as well as ambulance distance from the ambulance departure and ambulance come back to their depot. In this study a check list was used to extract information

covering time of crash, time intervals including time of emergency receipt call, time of ambulance movement toward scene, time of arrival at scene, time of patients' transportation and time of arriving to hospital. Figure 1 has illustrated these different time intervals.

Data source and case selection

Trained ambulance personnel in the EMS records information about patients of victims of RTIs, when the ambulance team members attend at the crash scene. Ambulance personnel are responsible for death and injury registration (see also data collection). For each patient there is a questionnaire for filling out by them. After data collection by technicians, these data will input to a central computer located to the ambulance site dispatch centre by a trained technician. Initially, all calls to ambulance centre were reviewed. In total, there were about 22,182 calls to EMS in Oroumiyeh that has resulted EMS activity. Among all calls during the study period, 2210 were related to RTIs. The inclusion criteria were, if they were qualified as RTI' victims and resulted in a ground ambulance dispatches and received service by them, e.g. they were transported from the scene by one of the region's EMS. Incident locations were defined as "city" and "interurban roads" if they occurred in the Oroumiyeh geographic area, according to the Statistical Centre of Iran definition. The cases that didn't have complete information about time intervals were excluded (183 cases). In total, 2027 cases were analyzed in this study.

Data analysis

Descriptive analysis on various pre-hospital time intervals including: activation interval, response interval, on-scene interval, transportation interval and the total pre-hospital intervals were investigated, using mean, median, mode, maximum, minimum and 95% confidence intervals. Moreover, bivariate analyses were conducted for time

intervals (five categories) and crash location (two categories) using t-tests and Chi ^{2} test, to detect significant association and differences ($P< 0.05$) in distributions between categorical and continuous variables, respectively. Moreover, the distribution of time of injury occurrence (four categories for hour of injury; seven categories for date of injury; and four categories for season of injury) was considered for city and interurban roads, using Chi ^{2} test. In order to test the difference between weekdays and seasons of injury occurrence in relation to crash location, the t-test used again. The SPSS version 13.00 (SPSS Inc, Chicago, IL, USA) was used for data analysis.

Ethical consideration

The study was approved by the Iranian National Ethics Committee at the Ministry of Health and Medical Education of Iran. Permission was also obtained from the Ministry of Health and Medical Education and the Urmia University of Medical Sciences.

Results

From all ambulance dispatches by EMS, 61.5% of RTIs victims were injured within city compare to 38.5% cases that occurred in interurban roads. In overall, 1.8% of all subjects died after EMS arrival at crash scene or on the route to hospitals. Among them, 27.7% deaths occurred at city and the rest at interurban roads.

Time intervals of EMS activities

Insert table I is about here

The mean values for different time intervals of the activities are summarized in Table 1. The mean of the response interval and on-scene interval were approximately the same. Transport interval was slightly longer than response intervals. The variation of the total time interval was long with a minimum and maximum of 14-114 minutes, respectively.

Insert table II is about here

Table 2 presents time intervals by measurements of central tendency in the EMS, stratified by city and interurban roads. The mean response time at interurban roads was longer than within city (10.6 minutes vs. 5.0 minutes, p<0.001). Moreover, on-scene interval was longer at interurban roads compare to city (9.2 vs. 6.1 minutes, p < 0.001). The transport time interval at both city and interurban roads was slightly longer than the response time interval. The mean of total pre-hospital time was almost twice at interurban roads compare to the city (p < 0.001).

Insert table III is about here

As Table 3 shows, there was no significant association between activation time for RTIs in city and interurban roads. However, there was significant association for victims' response time between city compare to interurban roads (p < 0.001). Focusing on total pre-hospital time intervals, around eight out of ten victims at city transported less than 30 minutes, while for victims of interurban roads one out of four had transported less than 30 minutes.

Response times varied significantly between city compare to interurban roads (P<0.001). Close to 90% of the victims within city had a response time of less than 8.0 minutes, compared to 45.7% of victims at interurban roads. There was a significant association for transportation interval time and crash site (P<0.001). In overall, 99.5% of victims of RTIs at city were reached to hospital within 20 minutes from the crash scene. Close to half of the cases at interurban roads reached to the hospital more than 45 minutes. Moreover, close to two-third of the victims at interurban road has transported within 45 minutes, compared to 96.7% of victims within city (P<0.001).

Insert table IV is about here

As table 4 shows, seven out of ten of the injuries occurred between 8.00 am and 8.00 pm. There was an association between time of injury occurrence and crash site (P<0.001); of which close to half of the injuries at interurban roads occurred between 14:01-20:00, which at the same time it is different from the injury occurrence at city area. There was an association between victims' crash site and days of the week (P=0.02).

Insert table V is about here

The effect of the date and season of injury on the mean time intervals (response time, transport time and total time interval) of the ambulance dispatches was also explored in this analysis. As table 5 shows, there was an association between mean of above time intervals during weekdays at crash location (P<0.05). However, none of the time intervals varied significantly between city and interurban roads areas, when the time intervals stratified by season (P<0.05).

Discussion

This study, the first in its kind in Iran, estimated the various time intervals and its differences at city-interurban roads. The time intervals in this study may be important indicators for EMS performance evaluation in terms of resource planning and assessing quality of patient care. Most of the time intervals mainly are lower than similar studies in Iran. The time interval between the RTI occurrence and the onset of care at a designated trauma centre has been thought to be an important predictor of victims survival [18, 19].

The response interval in this study was lower than finding in the capital city of Iran, 7.1 (±5.6) vs. 14.9 (± 6.72). The reason for this shorter interval compare to the capital city of Iran, mainly related to the infrastructure of the study area [16]. Oroumiyeh is a small city compared to Tehran, which is a very big city and usually suffers from

traffic congestion that can result delay in response time. Focusing on location of the injury occurrence, the response interval at interurban was longer than city. Other studies also revealed that rapid responses are believed to have major effect for the quality of care provided to trauma patients. If time to the trauma centre is a critical variable in the prediction of trauma outcome, then planners of emergency medical services in interurban roads areas may faced with the difficult task of providing services to victims in this geographic location from both pre-hospital care and hospital-based care [20, 21].

The on-scene interval in our study was shorter than findings in the capital city of Iran, 7.4 (±5.2) vs. 18.0 minutes in Tehran [14]. This time interval mainly can be affected by the skill of EMS team members as well as involvement of laypeople at crash scene. In recent years many activities toward EMS personnel skill carried out in the study area [15], which resulted their better performance of victims rescue. The other reason also to believe for such short interval could be related to the manner of people involvement as first responder and a sense of hast regarding victims transportation before ambulance arrival. A study in Iran indicated that, untrained laypeople feel that removing victims from the crash scene and taking them to hospital quickly is better for the victims [15]. This can result rapid extrication of the casualties from the trapped vehicles before arriving of the ambulance team members.. It is also important to note that, since motor vehicle crashes in interurban road areas involve higher collision forces with more severity of crash that may require longer extrication times, as a result which is line by Grossman et al. [20].

The transport interval in this study was shorter than other settings in Iran, 10.5 (±9.1) compare to 18.5 (12.10) in Tehran [22]. The reason for that again mainly related to the infrastructure of the city and availability of different hospitals and low traffic

congestion; which can provide facilities for victims' transportation. It is important to note that response time interval at interurban roads was significantly longer than that within city. However, compared to transport interval this variation was lower. This may imply that the location of the ambulance site dispatches is more suitable, which can result in better ambulances access to the victims, but they need more time for transportation to the hospital. As a result for this comparison, information regarding the effect of time on outcomes may be helpful in geographic setting of transport and first response teams as well as sites for ambulance dispatches.

In overall, the total pre-hospital time interval in this study was 37.2 minutes. Focusing on this time interval, when it stratified by crash occurrence at city and interurban roads, it was 29.2 and 45.0 minutes, respectively. Compare to a study in Tehran, our finding was low, 37.2 vs. 45.0. As explained earlier about the response time interval, the same reason could be considered for this difference. Moreover, in recent years, EMS dramatically improved in the country [23], including increasing in the number of ambulances and sites of ambulance dispatches ,improving in the equipment, and educational plans for emergency team staff [15]. All these factor can affect the shorter response and total pre-hospital time intervals.

As Calland (2005) noted that " the term Golden Hour, i.e. the first 60 minutes after crash occurrence, was first introduced in 1961, but due to misinterpretation as to what period this actually referred to, a second concept, the "Platinum Ten Minutes" was proposed as the time taken to move a victim to the ambulance. To achieve this rapid removal, the ambulance and medical personnel must work in harmony with the police and fire service to secure the scene and remove the RTIs victims safely without causing injury either to the casualty or other personnel on the scene".

Currently there is no available information about notification interval in this study, however as figure 1 shows, this time interval is a hidden part of total interval and it is crucial to the eventual outcome of each dispatches. This interval may be affected by many factors rather than improvement in the pre-hospital care. A study in the capital city of Iran revealed, the mean time between the crash occurrence and arrival at the hospital was 170 minutes, while the total time interval from notification to arrival hospital was 120 minutes [14]. This difference between injury occurrence and notification time can argue for the importance of evaluation of the notification interval in Iranian settings. [15], which currently is underway.

Limitation and strength of the study

Accuracy for filling out the data at questionnaire is one issue. It is important to note that the questionnaire used for data collection had been tested already by MOHME and used. Therefore, we believed that the questionnaire is valid and reliable. Moreover, data collected by the trained personnel in EMS. However, we recommend the quality control on the data collection process, which currently is underway. The future limitation of the study was about focusing on time intervals and not on quality of care. By data at hand we could focus on that part of data rather than the severity of the injury and a lack of analysis of potential correlations between injury type and severity. However, they were not the scope of this study. As strength of this study, to our knowledge, was the first study in the country that compared city-interurban roads association and difference for various time intervals, using all cases for a period of two years.

Conclusion

All time intervals among victims of interurban road areas are longer than city areas. The short response interval and transport interval compared to other settings may indicate improvement in the pre-hospital services in the study area. It is important for more attention and care on the notification interval that needs to be measured through establishment of surveillance system at EMS. It is an important recommendation for its improvement through public education, improvement in the telecommunication and integration of trauma system in the future. Public education campaign for emergency services numbers, member from public cooperation is also an important recommendation of this study. Finally, this study imply for investigation on the need-to and access-for emergency medical services, which currently is underway.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

MB has made substantial contributions to the conception and design of the study, and taken responsibility for and coordinated the acquisition of data, which she gathered and analyzed. She took an active part in the analysis of the data, in its abstraction and in the writing-up of the manuscript. DKZ contributed to the conception and design of the study, data collection process and he took an active part in the data analysis and results interpretation RM also took part in the writing-up and finalization of the manuscript. All authors read and approved the final manuscript.

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Table 1: Mean, median, mode, minimum and maximum of the time intervals of road traffic injury in the Oroumiyeh from 20 March 2005 to 20 March 2007.

Time intervals	Mean	Median	Mode	Min	Max	95% CI
Activation interval	1.4	1	1	1	8	1.39-1.46
Response interval	7.1	6	2	2	45	6.87-7.49
On-scene interval	7.4	6	5	3	25	7.06-7.64
Transport interval	10.5	7	5	3	57	9.96-10.95
Total time intervals	37.2	32	26	14	114	36.25-38.18

Table 2: Pre-hospital time intervals of road traffic injury stratified by crash location in the Oroumiyeh from 20 March 2005 to 20 March 2007.

Time intervals (minute)*	***City***		***Interurban roads***	
	Mean (SD)	*Median (0.25%-0.75%)*	*Mean*	*Median (0.25%-0.75%)*
Activation interval	*1.4 (0.6)*	*1 (1-2)*	*1.4(0.6)*	*1 (1-2)*
Response interval	*5.0 (3.1)*	*4 (3-7)*	*10.6 (7.0)*	*9 (6-13)*
On-scene interval	*6.1(3.7)*	*5 (4-7)*	*9.2 (6.7)*	*7 (5-11.3)*
Transport interval	*6.3 (3.6)*	*5 (4-8)*	*17.1(10.9)*	*14 (9-23)*
Total pre-hospital	*29.2*	*28 (22-34)*	*49.9*	*45 (35-62)*

* Despite of activation interval, all P-values were <0.001

Table 3: Proportion of the different time intervals of road traffic injury stratified by crash location in the Oroumiyeh from 20 March 2005 to 20 March 2007

Time intervals (minute)	City N=1246	Interurban roads N=781	Total N= 2027
Activation interval	**%**	**%**	**%**
≤ 2	98.1	99.2	98.5
> 2	1.9	0.8	1.5
	Chi-square= 0.9; P=0.29		
Response interval			
< 8	89.2	45.7	72.5
8-15	9.4	34.2	18.9
>15	1.4	20.0	8.6
	Chi-square= 301.3; P < 0.001		
On-scene interval			
< 5	51.2	37.2	45.8
5 -10	39.5	34.2	37.5
> 10	9.3	28.5	16.7
	Chi-square= 82.9; P < 0.001		
Transportation interval			
< 10	88.8	34.0	67.7
10-20	10.6	37.4	21.0
> 20	0.5	28.5	11.3
	Chi-square= 450; P < 0.001		
Total interval			
< 30	79.5	25.1	58.5
31-45	17.2	30.6	22.4
> 45	3.3	44.3	19.1
	Chi-square= 454; P < 0.001		

Table 4: Proportion of the time of RTIs occurrence at city and interurban roads in the Oroumiyeh from 20 March 2005 to 20 March 2007

Time, date and season of injury	City	Interurban roads	Total
	N=1246	N=781	N= 2027
Time of injury	*%*	*%*	*%*
08:01-13:00	33.0	29.8	31.7
14:01-19:00	35.4	48.2	40.3
20:01-01:00	26.1	16.8	22.5
02:01-07:00	5.6	5.3	5.5
	Chi-square= 25.1; P<0.001		
Date of injury			
Sunday	13.9	14.2	14.0
Monday	13.6	10.1	12.2
Tuesday	14.8	14.8	14.8
Wednesday	13.3	14.0	13.6
Thursday	16.5	12.1	14.8
Friday	15.1	21.9	17.7
Saturday	12.8	13.0	12.9
	Chi-square= 14.8; P=0.02		
Season of injury			
Spring	33.5	34.8	34.0
Summer	28.8	26.1	27.8
Autumn	20.9	24.1	22.1
Winter	16.8	15.0	16.1
	Chi-square= 3.0; P=0.3		

Table 5: Proportion of the time intervals at city and interurban roads stratified by date, season and crash occurrence in the Oroumiyeh from 20 March 2005 to 20 March 2007

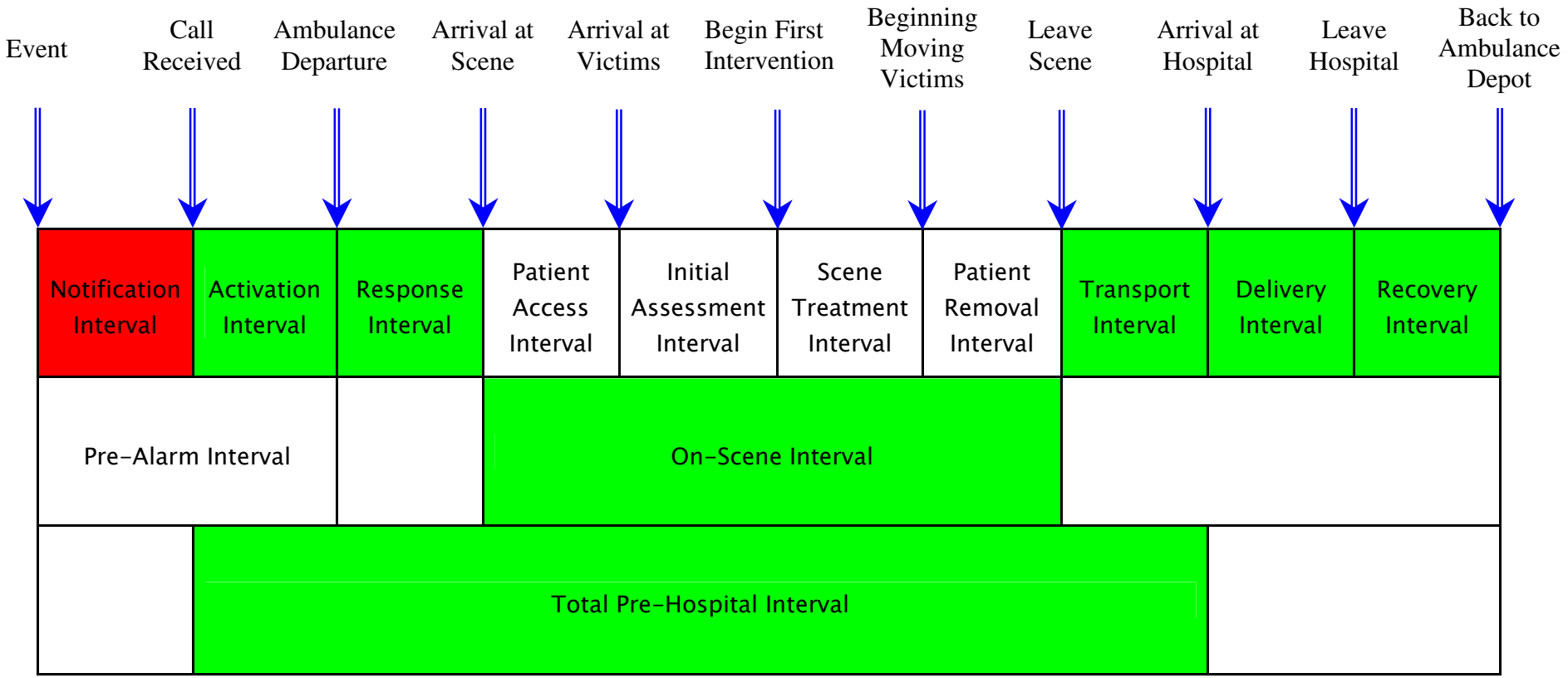
Time intervals (minute)	Mean*	
	City	Interurban roads
Weekday	**%**	**%**
Response time		
Sunday	5.1	8.9
Monday	5.0	10.8
Tuesday	4.7	11.3
Wednesday	4.5	11.1
Thursday	5.6	10.5
Friday	4.9	11.2
Saturday	4.8	9.9
Transport time		
Sunday	5.7	13.8
Monday	6.9	16.3
Tuesday	6.0	17.6
Wednesday	6.6	18.9
Thursday	6.5	15.6
Friday	5.3	23.7
Saturday	6.1	18.6
Total pre-hospital time		
Sunday	25.6	40.2
Monday	25.4	49.3
Tuesday	23.9	48.2
Wednesday	24.5	47.9
Thursday	26.5	44.1
Friday	23.8	52.1
Saturday	24.2	45.8
Season		
Response time		
Spring	5.0	9.6
Summer	4.7	10.5
Autumn	5.0	11.4
Winter	5.3	11.8
Transport time		
Spring	6.5	17.2
Summer	5.5	19.3
Autumn	5.9	17.8
Winter	7.0	20.1
Total pre-hospital time		
Spring	25.1	44.5
Summer	23.4	44.9
Autumn	25.2	48.1
Winter	26.5	56.2

* P values for all were <0.05

Figure 1

Figure 1: Specific intervals and points in time for road traffic injury victims.

Adapted with some modification from references [1, 2]



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